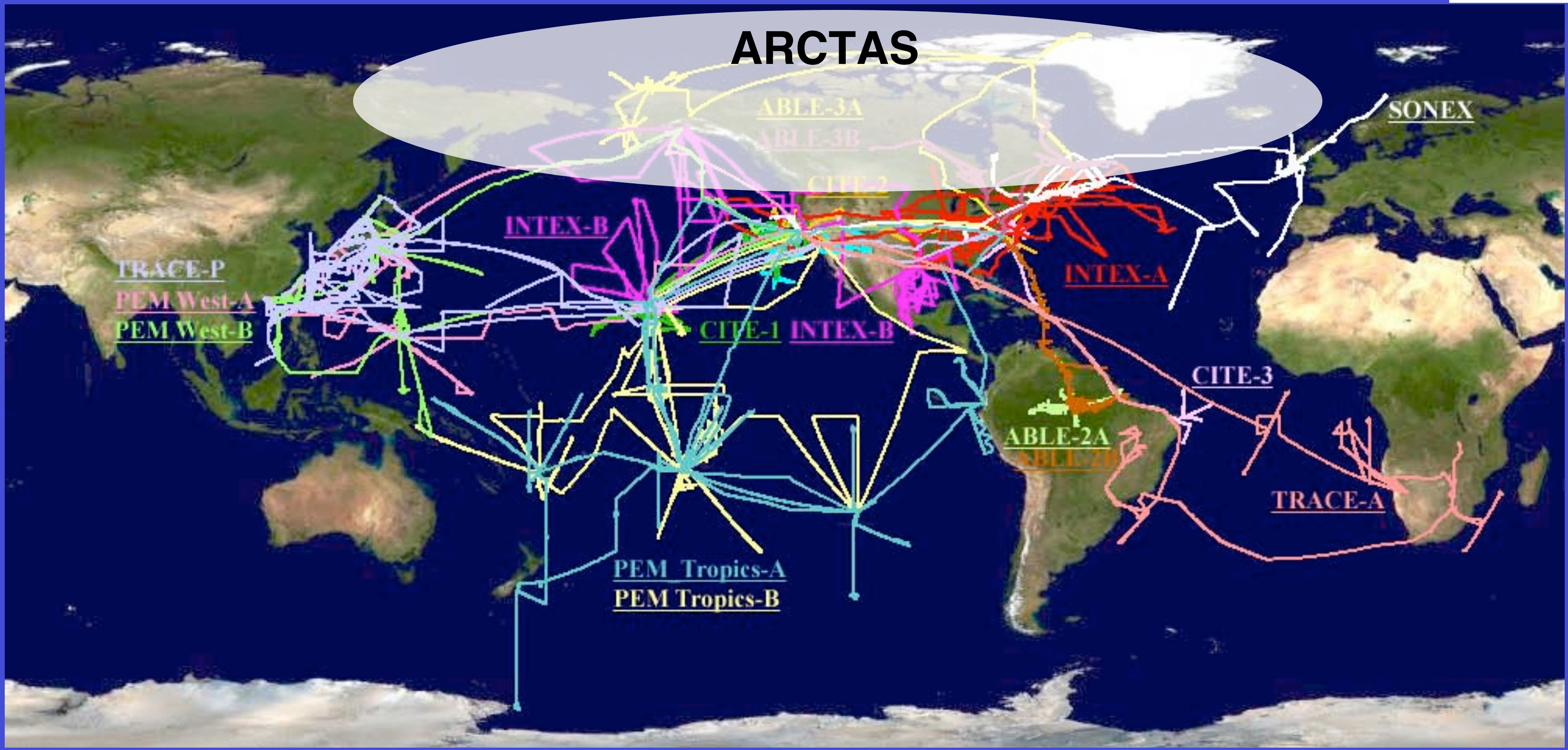
Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (ARCTAS)

next planned mission of the NASA Tropospheric Chemistry Program



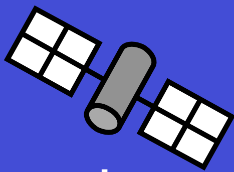
ARCTAS to be conducted in spring and summer 2008 (two phases) as part of the POLARCAT program during the International Polar Year (IPY)

ARCTAS white paper available: D.J. Jacob (lead), W.H. Brune, B. Cairns , K. Chance, J. H. Crawford, J. E. Dibb, J.C. Gille, R. Kahn , Q. Li, W. McMillan, B. Pierce, L.A. Remer, P.B. Russell, H.B. Singh, C.R. Trepte, J. Worden

ARCTAS STRATEGY: use aircraft to increase value of satellite data for models of arctic atmospheric composition and climate

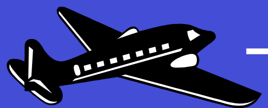
Satellites: CALIPSO, Cloudsat, MODIS, MISR TES, OMI, HIRDLS, MLS, AIRS, MOPITT

- Aerosol optical depth, properties
- CO, ozone, BrO, NO_2, HCHO



Aircraft: DC-8, J-31, B-200

- Detailed in situ chemical and aerosol measurements
- Remote sensing of ozone, aerosol, surface properties



Retrieval algorithm development & validation
Correlative information
Model error characterization

Models: CTMs, GCMs, ESMs

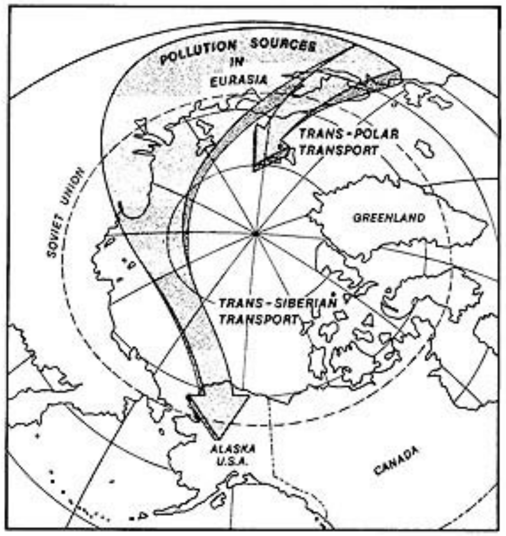
- Source-receptor relationships for Arctic pollution
- Effects of boreal forest fires
- Aerosol radiative forcing
- Arctic chemistry

Data assimilation
Diagnostic studies

Two 1-mo deployments: April and July 2008

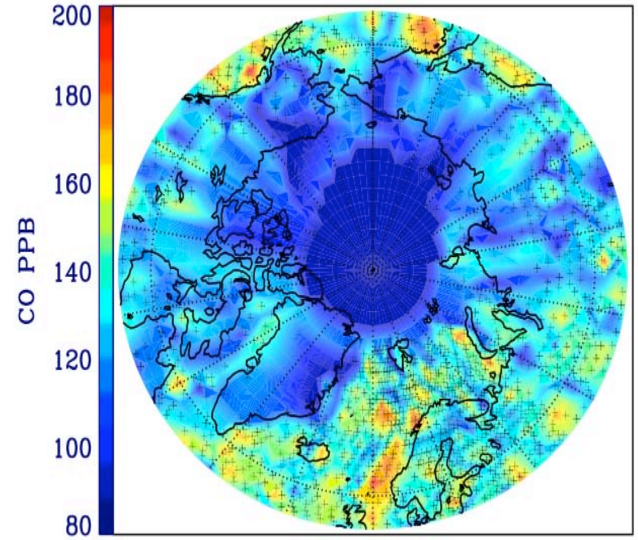
ARCTAS Science Theme 1: winter/spring long-range transport of pollution to the Arctic

European influence



Arctic haze

TES 600 hPa CO, March 2006



J. Worden, JPL

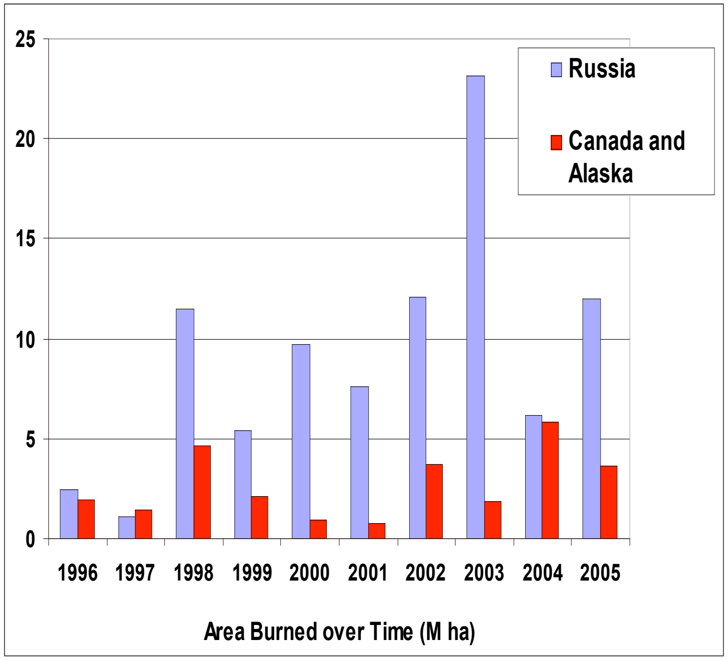
- What are the transport pathways for different pollutants?
- What are the contributions from different source regions, the source-receptor relationships?
- What is the interannual variability (e.g., Arctic Oscillation)?

Satellite capabilities:
- CO (TES, AIRS, MOPITT)
- O_3 (TES)
- aerosol (CALIPSO, MODIS, MISR)

Aircraft added value:
- detailed chemical composition
- tracers of sources
- vertical information

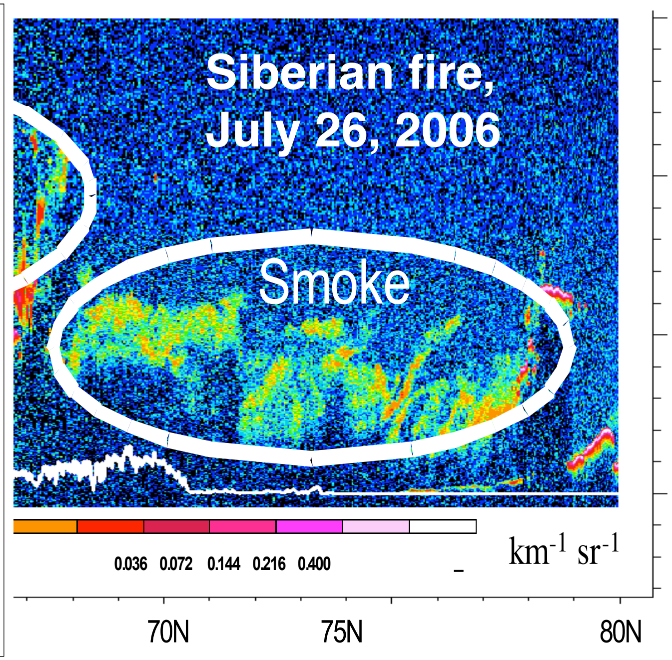
ARCTAS Science Theme 2: Boreal forest fires

Fire trend over past decade



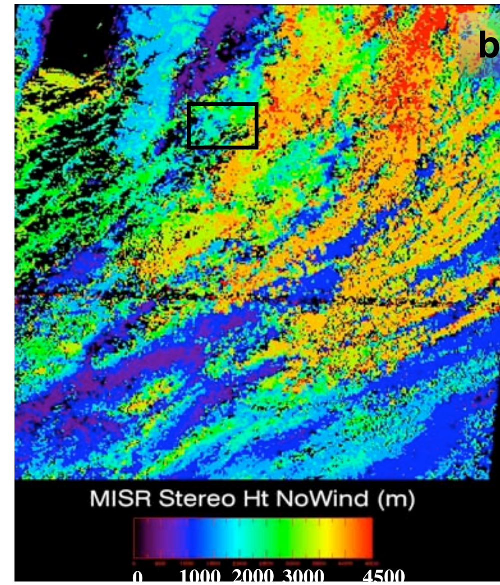
A. Soja, LaRC

CALIPSO view of fire plume



C. Trepte, LaRC

MISR injection height



R. Kahn, JPL

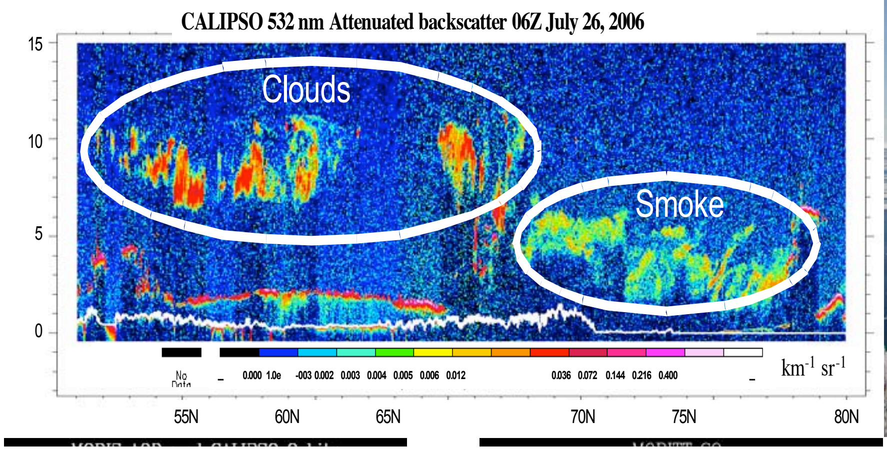
- What is the chemical composition & evolution of the fire plumes?
- What are their aerosol optical properties, how do these evolve?
- What are the injection heights, what are the implications for transport & chemistry?

Satellite capabilities:
- plume layers (CALIPSO)
- injection heights (MISR)
- aerosols (MODIS, MISR, OMI)
- CO (TES, AIRS, MOPITT, MLS)

Aircraft added value:
- detailed chemical composition
- aerosol properties
- pyroconvective outflow

ARCTIC Science Theme 3: Aerosol radiative forcing

CALIPSO clouds and smoke



C. Trepte, LaRC

Arctic haze

MISR true-color fire plume

R. Kahn, JPL

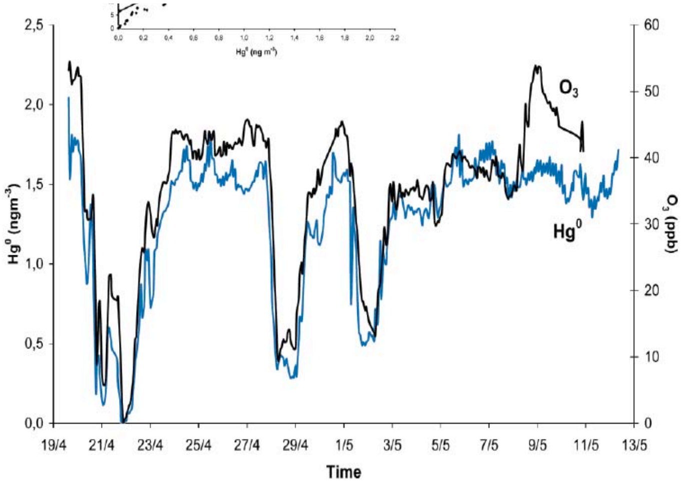
- What is the regional radiative forcing from Arctic haze, fire plumes?
- How does this forcing evolve during plume aging?
- What are the major sources of soot to the Arctic?
- What is the effect of deposited soot on ice albedo?

Satellite capabilities:
- UV/Vis/IR reflectances (Cloudsat, MODIS, MISR, OMI)
- multi-angle sensing (MISR)
- lidar (CALIPSO)

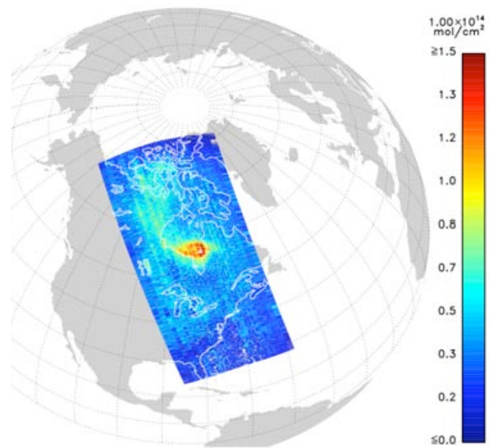
Aircraft added value:
- detailed in situ aerosol characterization
- remote sensing of radiances, fluxes
- BRDF of surface

ARCTAS Science Theme 4: Chemical processes

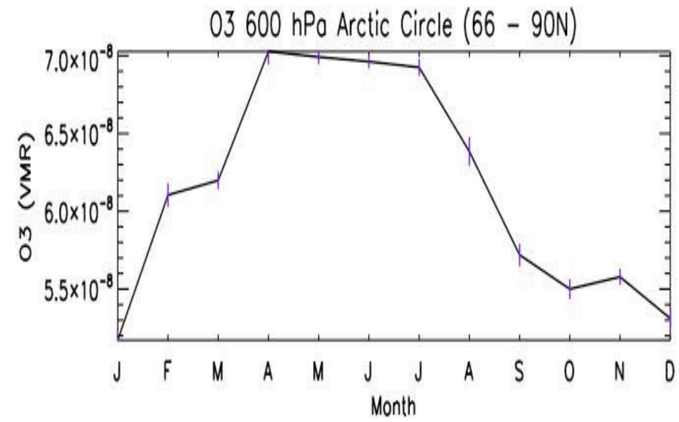
Ozone, Hg depletion events | **OMI tropospheric BrO** | **TES tropospheric ozone**



Sprovieri et al. [2005]



K. Chance, Harvard/SAO



J. Worden, JPL

- What is the HO_x/NO_x chemistry in the Arctic?
- What drives halogen radical chemistry in the Arctic, what is its regional extent?
- What are the regional implications of halogen chemistry for ozone and mercury?
- How does stratosphere-troposphere exchange affect tropospheric ozone in the Arctic?

Satellite capabilities:
- Ozone (TES, OMI/MLS)
- BrO (OMI)
- strat-trop exchange (HIRDLS)
- CO (TES, AIRS, MOPITT)

Aircraft added value:
- detailed chemical characterization, constraints on photochemical models
- validation of OMI tropospheric BrO
- HO_x measurement intercomparison

AIRCRAFT PLATFORMS, PAYLOADS

DC-8: major in situ platform

Ceiling 37 kft, range 4000 nmi, endurance 9 h

Payload: O_3, H_2O, CO, CO_2, CH_4, NO_x and HO_x chemistry, BrO, halogen reservoirs, mercury, NMVOCs, halocarbons, SO_2. HCN/CH_3CN, actinic fluxes, aerosol mass and number concentrations, aerosol physical and optical properties, remote ozone and aerosol

J-31: major aerosol remote sensing platform

Ceiling 26 kft, range 800 nmi, endurance 5 h

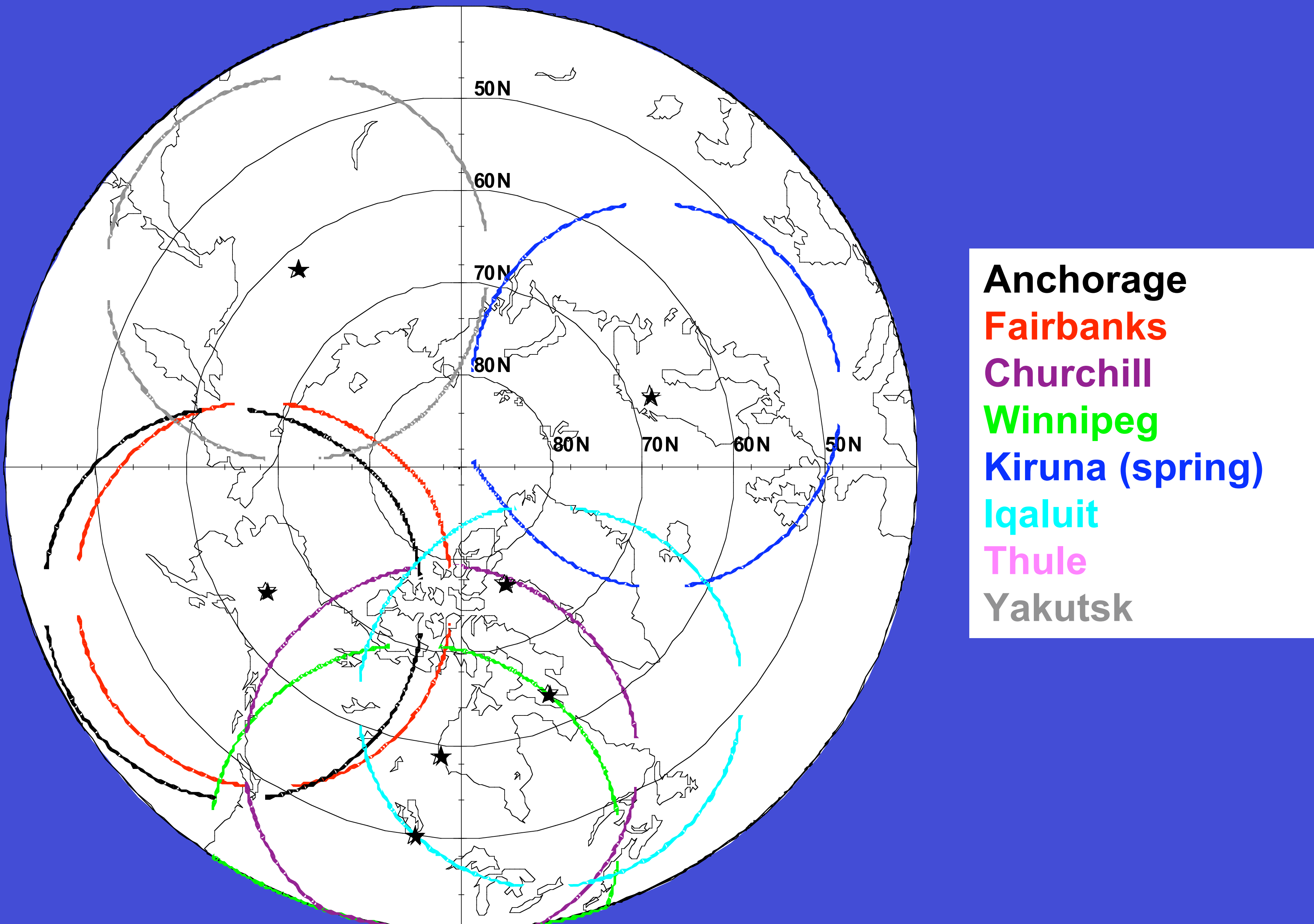
Payload: optical depth, radiative flux, radiance spectra

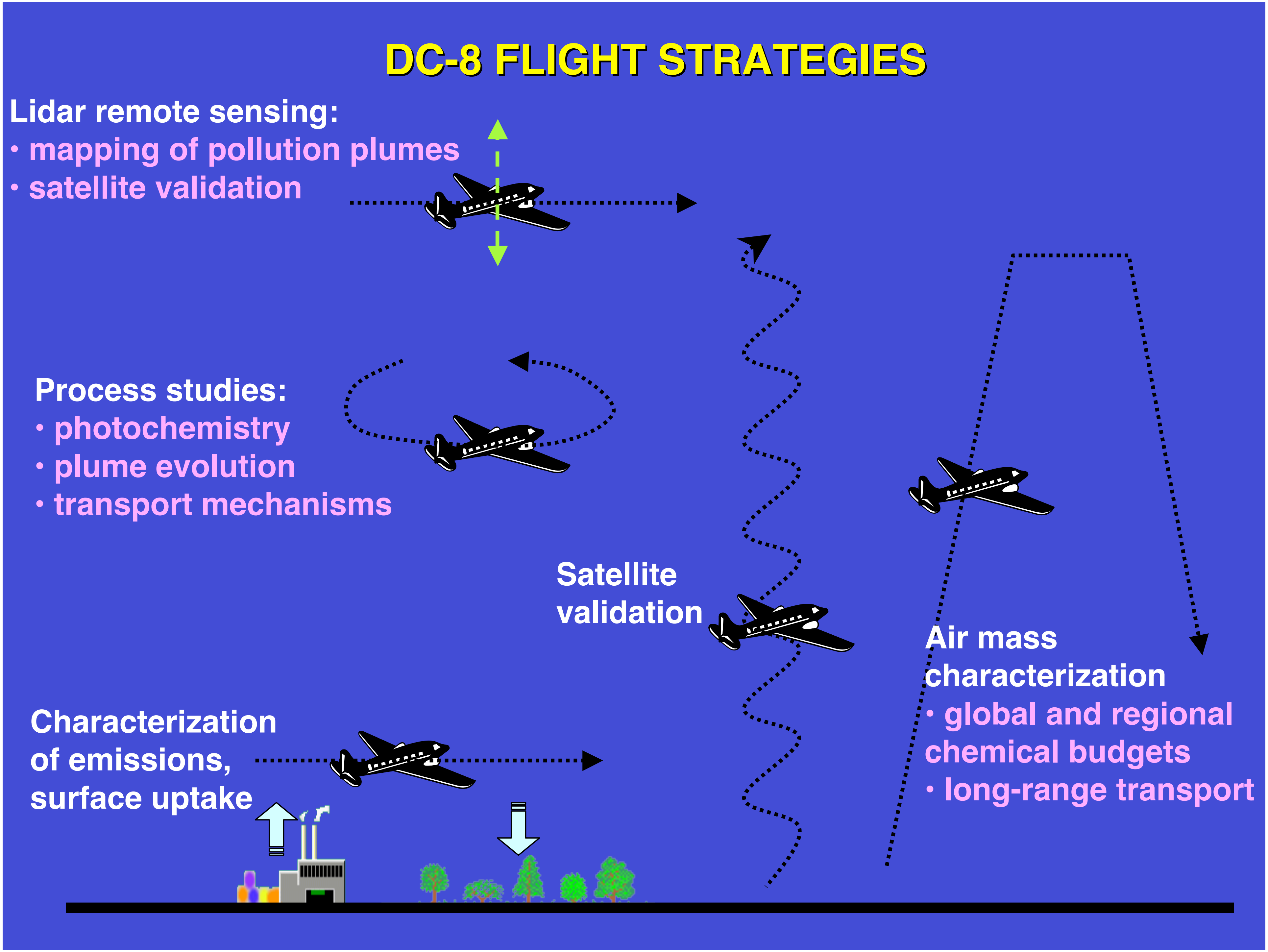
B-200: major CALIPSO validation platform

Ceiling 32 kft, range 800 nmi, endurance 3.5 h

Payload: High Spectral Resolution Lidar (HSRL)

POTENTIAL ARCTAS BASES AND NOMINAL DC-8 RANGES




DC-8 FLIGHT STRATEGIES
Lidar remote sensing:
• mapping of pollution plumes
• satellite validation
Process studies:
• photochemistry
• plume evolution
• transport mechanisms
Satellite validation
Air mass characterization
• global and regional chemical budgets
• long-range transport
Characterization of emissions, surface uptake